NOAA Proposed Alternative Dissemination Methods (ADM) for Environmental Data and The Multi-Constellation User Terminal (MCUT)

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Outline

- **Alternative Dissemination Methods (ADM) System**
  - Definition
  - Overview
  - Current Activities
  - Summary
- **Multi-Constellation User Terminal (MCUT)**
  - Definition
  - Overview
  - Current Activities
  - Summary
- **Future Plans**

ADM DEFINITION

What is ADM?

- ADM is the dissemination of multi-satellite data (includes sounder and imagery) from environmental spacecrafts and hydrometeorological information.
- Dissemination methods:
  - Internet (such as FTP request)
  - DOMSAT to ADM User Terminal
  - Dedicated Landline
  - Etc.
- ADM is <u>NOT</u> Direct Readout.
  - ADM does not use government spacecraft
  - ADM may re-transmit Direct Readout data
  - ADM may supplement Direct Readout Broadcasts

Why ADM?

- METOP Era
  - APT am mission replaced by LRPT
  - HRPT stations must upgrade to acquire AHRPT broadcast
- NPOESS Era
  - APT and HRPT services are terminated
  - LRD and HRD services require new field terminals
- GOES-R Era
  - High date rate increase from 2.2 mbps to 72 mbps
  - GVAR terminal must be replace with a new X-band station ($)
- Users require data from more than one satellite constellation

ADM OVERVIEW

ADM Overview

- CGMS XXVIII at Woods Hole, MA. (October, 2000)

  - CGMS asked satellites operators to review alternatives to direct readout

- CGMS Ad Hoc Committee on Data Dissemination in Geneva, SW. (January, 2001)

  - CGMS asked satellite operators to investigate alternative dissemination methods

- GOES-R Conference (I-II) (2001&2)

  - Users conveyed need for multiple satellite data

ADM Overview (cont.)

- CGMS Ad Hoc Committee on Data dissemination (April 2002)

  - NOAA presented plans for future alternative data dissemination

- WMO Committee for Basic Services Expert team on Satellite Systems Utilization and Products (April 2002)

  - NOAA adopts the WMO recommendations on alternative dissemination methods

ADM Overview (cont.)

- NOAA has conducted two ADM Studies
  - NOAA ADM Proof of Concept Study(2003)
    * Aerospace completed Study (October 2003)
  - NOAA ADM Concept Definition Study (2004)
    * Aerospace completed Study (October 2004)

Benefits of ADM

- High data rates of several Mb/s, a wide range of data and products with a good timeliness;
- Flexibility allowing enhancement of dissemination during the lifetime of a satellite generation with additional products that were not included in the initial design of a satellite system and latest R&D results;
- Capability to include data from spacecraft that were out of the visibility of the user;
- Availability of low cost user terminals;
- Enhancing data access through ADM;

Benefits of ADM (cont.)

- Makes the data available to a wider audience;

- Facilitates a smooth transition between different satellite generations for the user community;

- Combines reception of satellite data with the reception of other meteorological data, which would save costs since the same or similar terminals could be used;
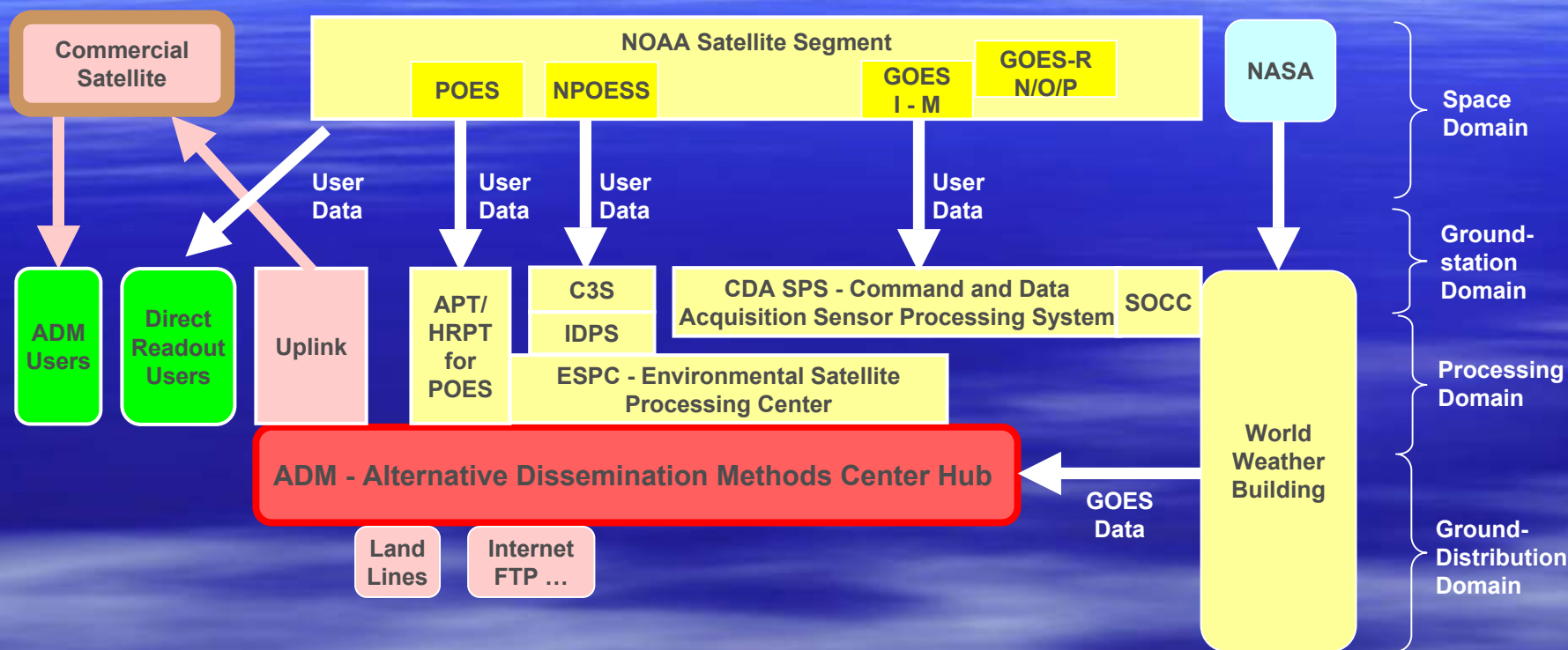
ADM CURRENT ACTIVITIES

ADM Approaches

- Communication Resources
  - Methods of transmitting data, point to point, or point to multi-point.
    - Internet
      - FTP service or Data Streaming
    - DOMSAT (Domestic Satellite, Commercial Communications Satellites)
      - Utilize ADM Common User Terminal
    - Dedicated Fiber Optic Cables (Landlines)
- ADM User Terminal
  - Recommend a user terminal that will work with commercial communications satellites for the reception of ADM broadcast

13

ADM Systems View (SV–1)
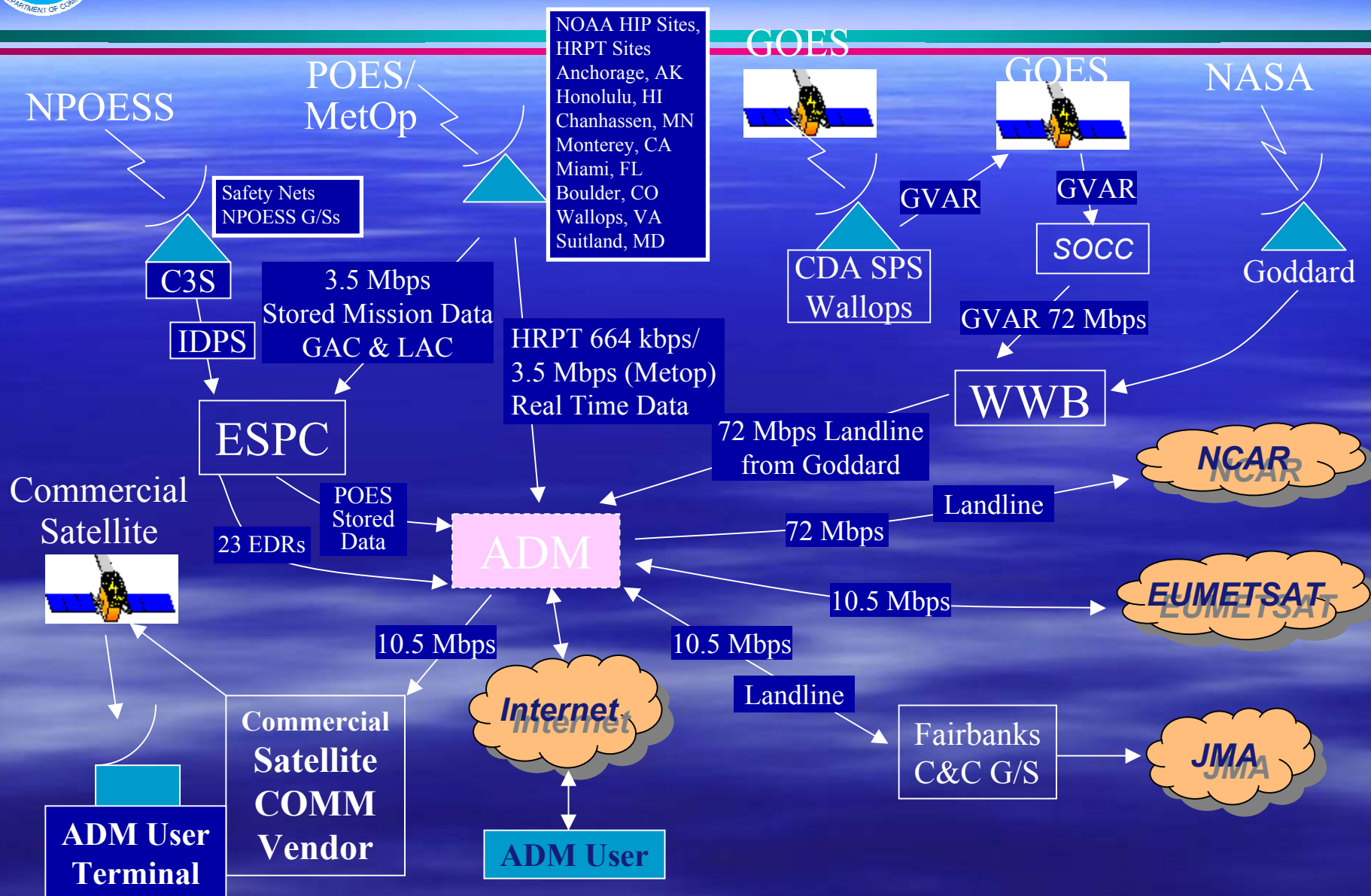
System Interface Description (Diagram)

NOAA Satellite Segment

- POES
- NPOESS
- GOES I - M
- GOES-R N/O/P

Commercial Satellite

NASA

Space Domain

User Data (×5)

ADM Users

Direct Readout Users

Uplink

APT/ HRPT for POES

C3S

IDPS

CDA SPS - Command and Data Acquisition Sensor Processing System

SOCC

ESPC - Environmental Satellite Processing Center

Ground-station Domain

Processing Domain

ADM - Alternative Dissemination Methods Center Hub

GOES Data

World Weather Building

Ground-Distribution Domain

Land Lines

Internet FTP …

Acquisition Authority Legend

Color	Authority
NOAA	
ADM	
ADM	
User	
Commercial	
NASA	

Acquired by ADM

Leased by ADM

ADM-Related Communication

NPOESS

POES/MetOp

NOAA HIP Sites,
HRPT Sites
Anchorage, AK
Honolulu, HI
Chanhassen, MN
Monterey, CA
Miami, FL
Boulder, CO
Wallops, VA
Suitland, MD

GOES

GOES

NASA

Safety Nets
NPOESS G/Ss

C3S

IDPS

3.5 Mbps
Stored Mission Data
GAC & LAC

HRPT 664 kbps/
3.5 Mbps (Metop)
Real Time Data

GVAR

SOCC

GVAR

GVAR 72 Mbps

Goddard

CDA SPS
Wallops

ESPC

WWB

POES
Stored
Data

23 EDRs

Commercial
Satellite

72 Mbps Landline
from Goddard

Landline

NCAR

ADM

72 Mbps

Landline

10.5 Mbps

EUMETSAT

10.5 Mbps

10.5 Mbps

Internet

Landline

Fairbanks
C&C G/S

JMA

Commercial
Satellite
COMM
Vendor

ADM User
Terminal

ADM User

ADM

NASA

GOES

NPOESS

POES

:

(representative data)

Broadcast Management Center
- Receives data
- Selects programming
- Assembles broadcast

10.5 Mbps

Network Management Center
- Routes data
- Formats data
- Transmits data

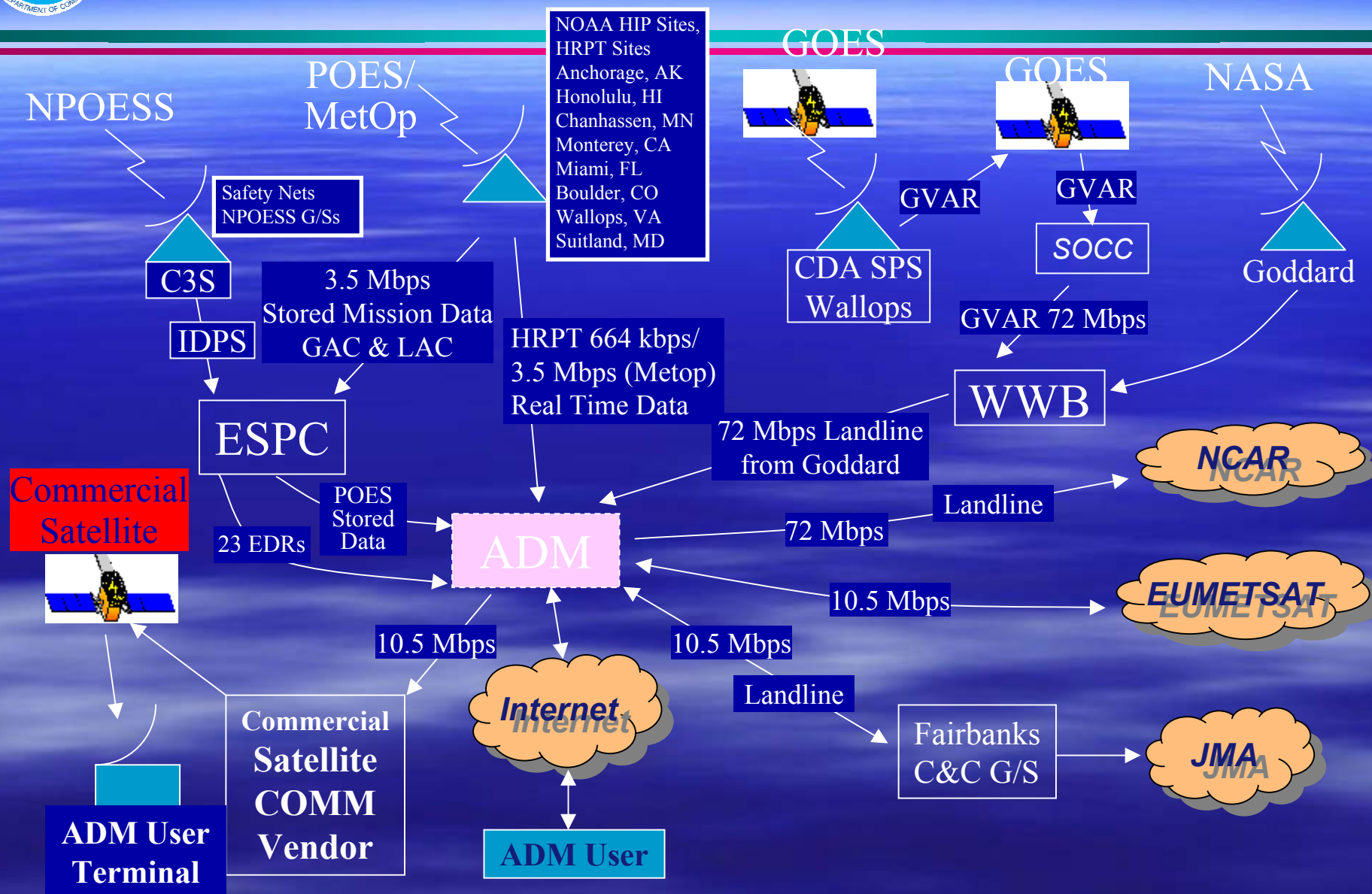**Commercial Satellite**

Internet FTP Requests

Landlines 72 Mbps

ADM Broadcasting System

- The ADM Management Center must be divided into two functions:
  - Broadcast Management Center (BMC)
    - Determines which programs will be on the broadcast, and their order.
    - Operated by NOAA
    - Receives programming from multiple sources
    - Assembles the Broadcast and sends it to the NMC
  - Network Management Center (NMC)
    - Routes data
    - Formats data
    - Transmits data
    - Contains communications hardware for transmission
      - Satellite dishes, modems, amplifiers
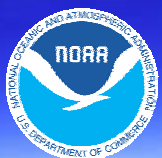
Commercial Communications

NOAA HIP Sites, HRPT Sites
Anchorage, AK
Honolulu, HI
Chanhassen, MN
Monterey, CA
Miami, FL
Boulder, CO
Wallops, VA
Suitland, MD

GOES

GOES

NASA

NPOESS

POES/ MetOp

Safety Nets
NPOESS G/Ss

C3S

IDPS

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from Goddard

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ADM

10.5 Mbps

EUMETSAT

Commercial
Satellite
COMM
Vendor

10.5 Mbps

Internet

10.5 Mbps

Landline

Fairbanks
C&C G/S

JMA

ADM User
Terminal

ADM User

18

Intelsat 802 Distribution to Pacific

INTELSAT 802 174.0° East

C-Band Global
29 | 31 | 33

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http://www.SatcoDX5.com/1740
Coverage Code INT802GL

4.2 GHz Downlink

INTELSAT 802 174.0° East

Ku-Band NE Asia
42 | 45 | 49

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http://www.SatcoDX5.com/1740
Coverage Code INT802KA

11.5 GHz Downlink

EIRP powers in dBW

Ku-band Distribution to North America

TELSTAR 5 263.0° East

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Ku-Band
38 46 50

http://www.SatcoDX7.com/2630
Coverage Code TES005KB

12 GHz Downlink

AMC 5 281.0° East

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Ku-Band
37 42 47

http://www.SatcoDX8.com/2810
Coverage Code AMC005KB

12 GHz Downlink

EIRP powers in dBW

Distribution to South / Latin America

NAHUEL I 288.2° East

Ku-Band Region 3
41 | 43

http://www.SatcoDX8.com/2882
Coverage Code NAH001K3

BRASILSAT B1 290.0° East

C-Band Regional
26 | 32 | 34

http://www.SatcoDX8.com/2900
Coverage Code BRA0B1CR

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11.5 GHz Downlink

EIRP powers in dBW

3.7 GHz Downlink

ADM User Terminal Diagram

Antenna

Receiver

PC workstations for data management and exploitation

Antenna Pointing

Power Supply Units

Software

ADM User Terminal Subsystems

- Antenna - ~$500 USD
  - Antenna cost increases with size
- Antenna Pointing (included in antenna price)
  - Non-tracking GEO Antenna for ADM User Terminal will be less expensive than Tracking LEO Antenna
- Receiver
  - LNB - ~$350 USD
  - DVB-S (Digital Video Broadcast-Satellite) PCI (Personal Computer Interface) Card - ~$60 USD
  - Receive Only (no transmit) will save amplifier cost
- Power supply units (provided by user)
  - Portable, voltage controlled supply for computer and receiver
- PC workstations for data management and exploitation - ~$2000 USD
- Software - ~$500 USD
  - Nominal Software Cost, does not include image processing software
- Total: ~$3410 USD

Dedicated Fiber-Optic Cable Links

NPOESS

POES/MetOp

NOAA HIP Sites,
HRPT Sites
Anchorage, AK
Honolulu, HI
Chanhassen, MN
Monterey, CA
Miami, FL
Boulder, CO
Wallops, VA
Suitland, MD

GOES

GOES

NASA

Safety Nets
NPOESS G/Ss

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Internet

Landline

Commercial
Satellite
COMM
Vendor

Fairbanks
C&C G/S

JMA

ADM User
Terminal

ADM User

Dedicated Fiber-Optic Cable

- 3 T1s from Fairbanks to SOCC (Suitland) currently used:
  - Bi-directional
  - Capacity:

    2 * 3 * 1.544 Mbps = 9.264 Mbps
- 3 T1s from Wallops to SOCC (Suitland) currently use:
  - Bi-directional
  - Capacity:

    2 * 3 * 1.544 Mbps = 9.264 Mbps

Ref: Les Shipley 301-457-5133 x182, Sep 2003

ADM SUMMARY

Summary

– Determine cost effective architectures for data dissemination
– Determine ADM user terminal configuration and cost
– Internet distribution is not the only solution for ADM
  - Commercial Communications Satellites also have a role in ADM
– Conformance to DVB-S (Digital Video Broadcast-Satellite) provides the lowest system cost
  - Conformance to DVB-S needed for low cost user terminal cost
– Standard data rates for DVB-S service
  - 16.3 to 47.2 Mbps, dependent on EIRP and Bandwidth available
– ADM user terminal cost about ~$3,500 USD (includes antenna, PC and software)
– Commercial Communications Satellite is the only solution for remote areas

MCUT DEFINITION

Why MCUT?

- Continue support for direct readout beyond NOAA-N'
  - Support increased data rates and new broadcast formats
  - Support a common data format for legacy field terminals
- Users require data from more than one satellite constellation
  - Reduce the number of field terminals to acquire the maximum amount of data

MCUT OVERVIEW

MCUT Overview

- CGMS Ad Hoc Committee on Data Dissemination in Geneva, SW. (January, 2001)
  - CGMS satellite operators investigate the possibility of establishing a global data dissemination service with common frequency, common bandwidth, CGMS global specifications for AHRPT and comparable data content.
- GOES-R Conference (I-II) (2001&2)
  - Users conveyed need for data from multiple satellites
- NPOESS Field Terminal Users Form (2003)
  - NOAA announced field terminal design shall include capability of acquiring data from more than a single satellite

MCUT Overview (cont.)

- NOAA has conducted two MCUT Studies
  - NOAA MCUT Prototype Design and Proof of Concept Study(2003)
    * Aerospace completed Study (March 2004)
  - NOAA MCUT Design Improvement Study (2004)
    * Aerospace completed Study (October 2004)

MCUT CURRENT ACTIVITIES

MCUT Objectives

- Demonstrate user terminal design capable of sequentially receiving several meteorological satellite services

- Develop/demonstrate user terminal technologies for low cost implementations

MCUT PROTOTYPE FEATURES

- Integrated antenna/receiver
- ASIC-based receiver
  - VHF, UHF, L-, and S-band cover heritage and future services
  - Low cost wireless technology
- L- and S-band antenna feeds
  - Commercial and military users increase production volume
- Low cost positioner to track polar satellites
- Interference protection provided

MCUT Receiver Implementation

- Custom designed, COTS-based four band analog downconverter
- Selectable IF Bandwidths
- 100 Msps A/D Converter
- Intersil Digital Tuner/Demodulator
- STEL Viterbi Decoder
- Cypress USB Controller
- Laptop computer for control and display

MCUT

File System Help
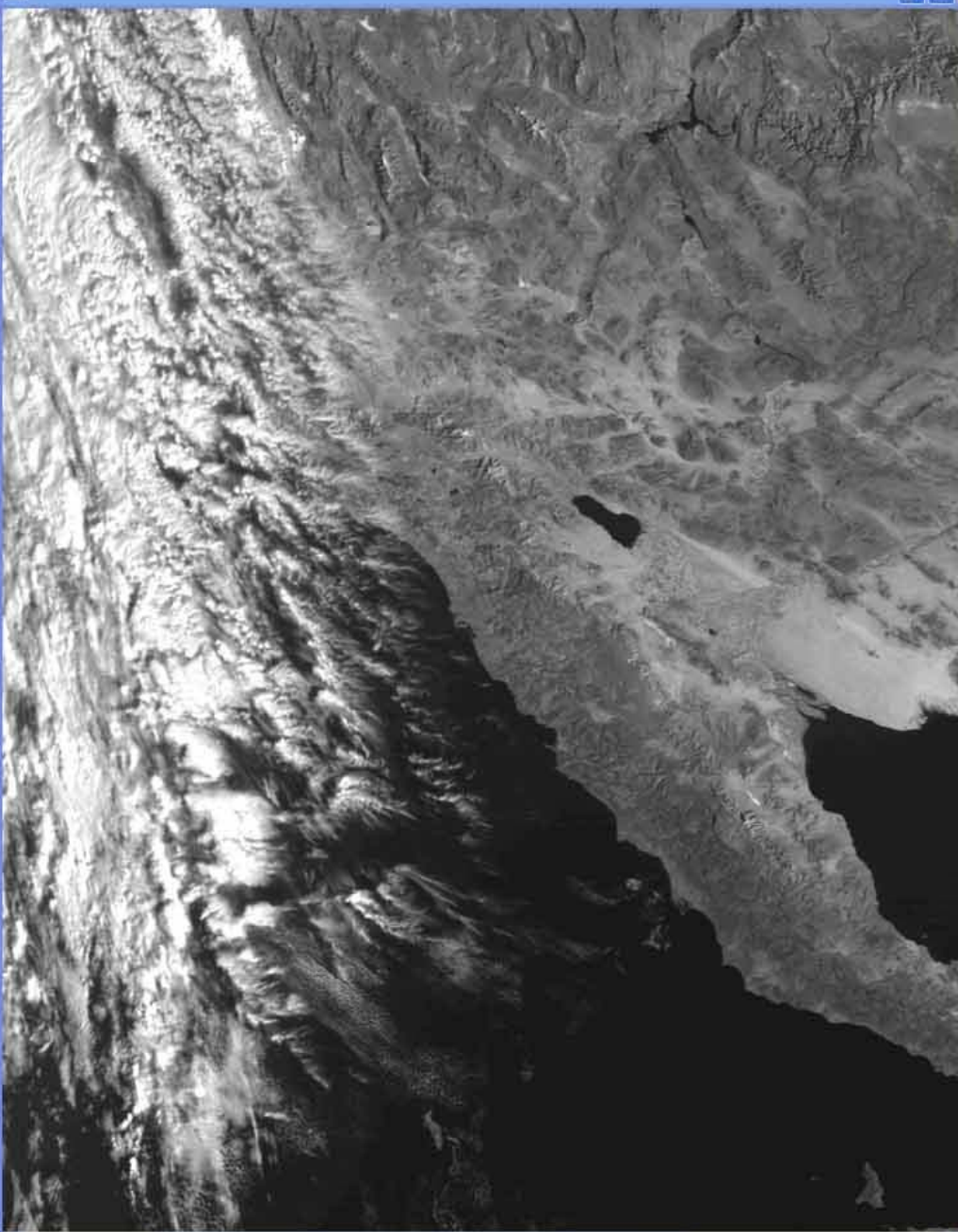
Seconds to Track

AZIMUTH

| Enable | Disable |

Disabled

CCW ———————— CW

Az Command Position

Stop

Stow

Manual Position

Command Position

ELEVATION

| Enable | Disable |

Disabled

0 ———————— 180

El Command Position

Load Ephemeris   Track Satellite   Stop Track

Limit Override

ON   OFF

Receiver Setup

| Service | Frequency | Channel |
| CHRPT | 1698.0 | 1 |

Receiver Status

Demod	Search	Carrier Offset	0.00
AGC	0.00	Symbol Offset	0.00
Tuned Freq	1698.0	IF Bandwidth	7 MHz

Data Control

Data On		Start Playback	Pause
Data Off		Stop Playback	Continue
Auto Data On	☑	Slow ——— Fast

Clear

CHRPT FRAME SYNC

40
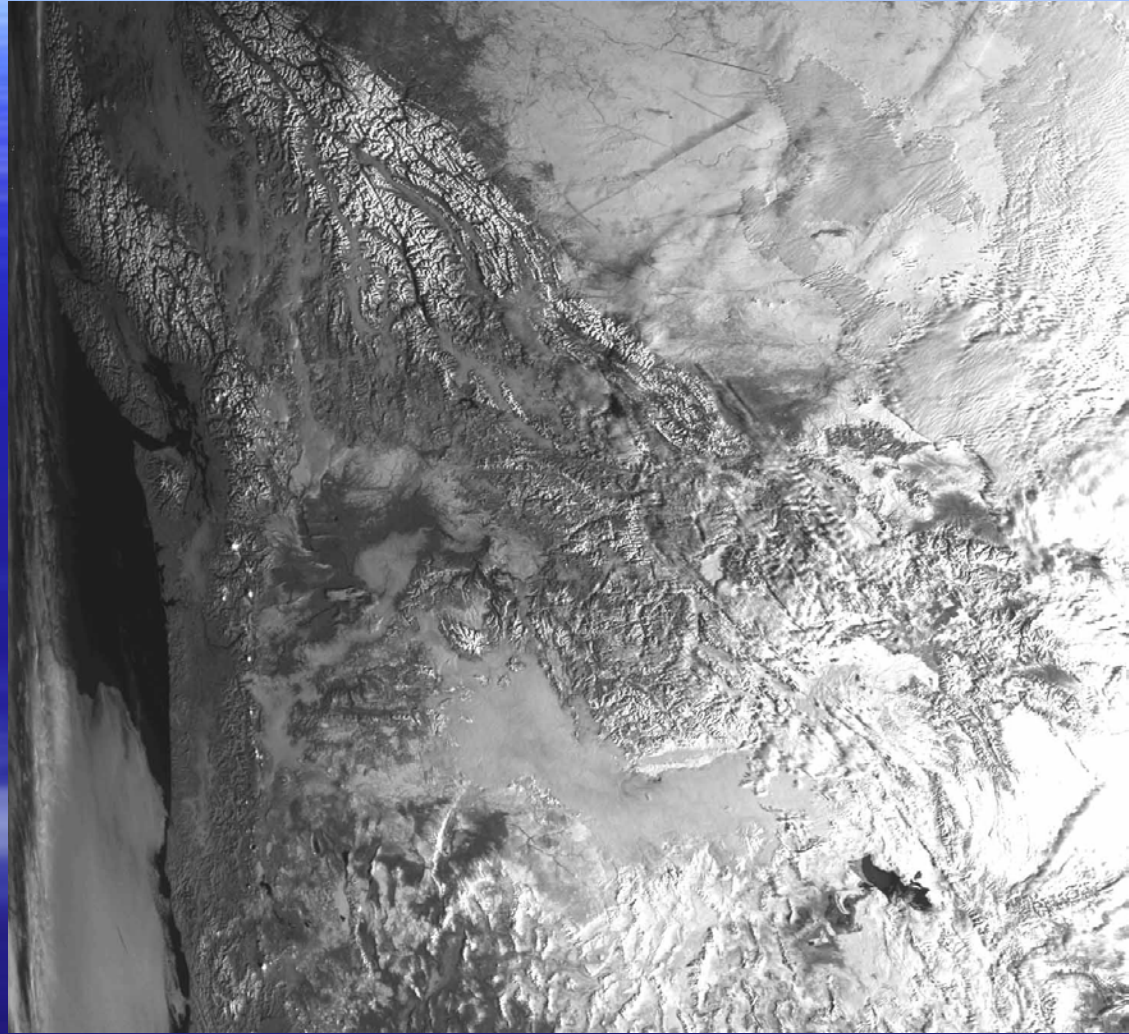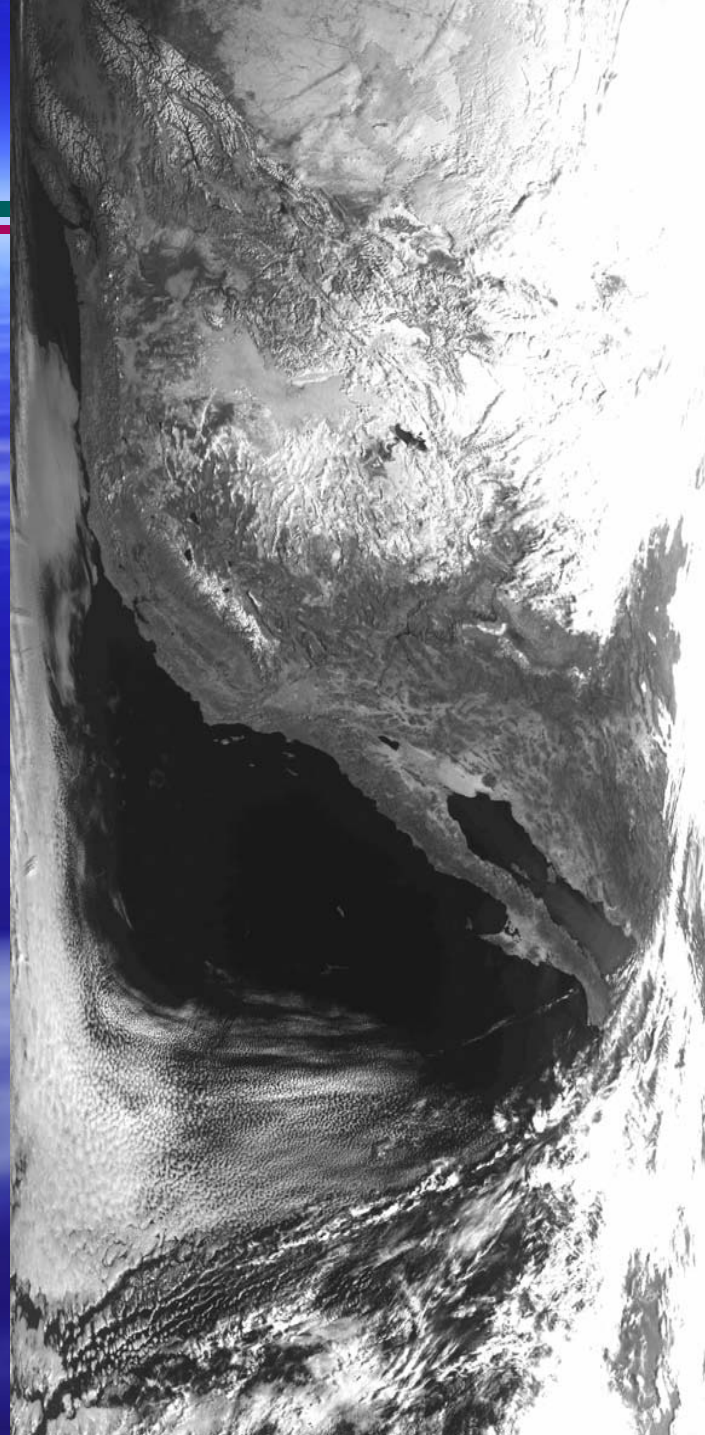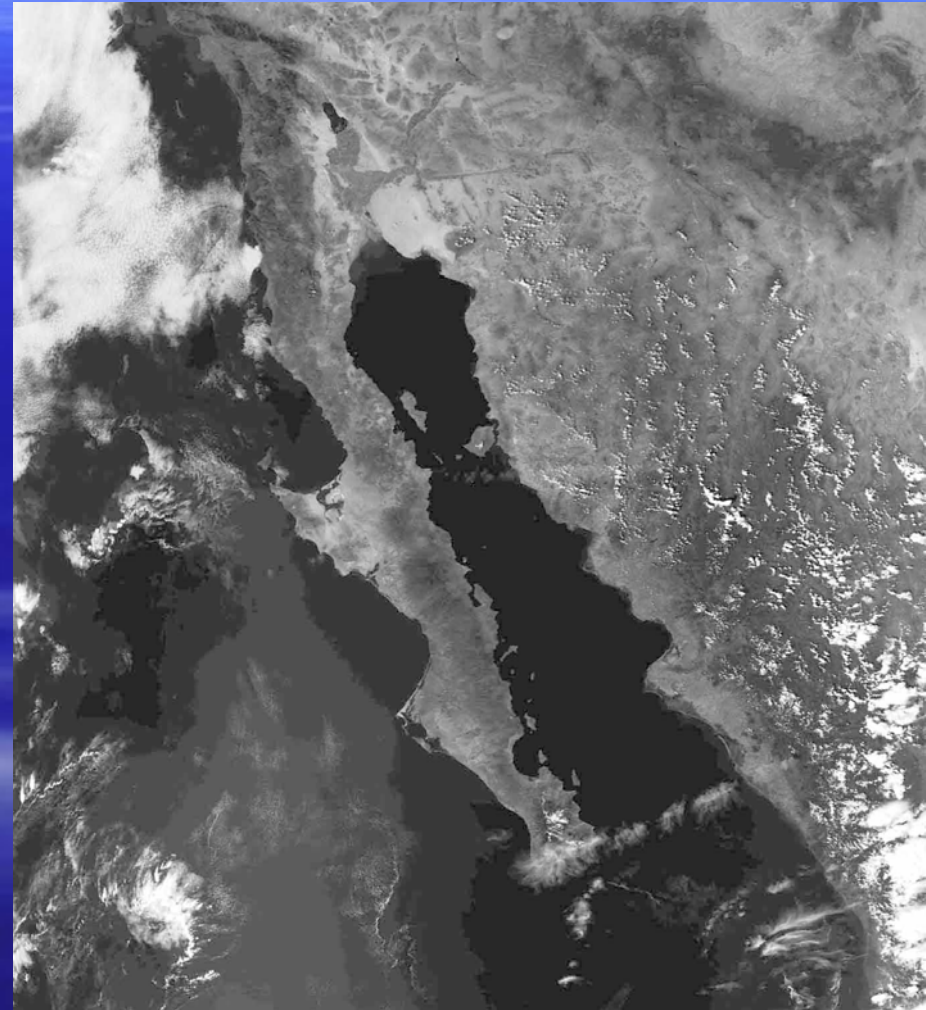
MCUT SUMMARY

Summary

- Prototype demonstrates technology that can be applied to different user requirements and applications

- Low cost implementation

- Increased production volume

- Common technology simplifies manufacturing

- Time sharing between polar and geostationary satellites provides meteorologists' needs with a single terminal

FUTURE PLANS

Future Plans

ADM Planned Activities

- Fine tune the ADM systems simulations
- Build realistic subnet models, and build accurate NOAA network topology
- Complete Network Configuration, Frame Format and User Application surveys
- Run network simulations

Future Plans

ADM Planned Activities (cont.)

- Analyze commercial wireless applications
- Assess the hardware and software cost for development of the 1st phase ADM systems
- Assess development and test schedules
- Assess deployment schedules
- Study interoperability with EUMETSAT and JMA

Future Plans

MCUT Satellite Reception Goals

Satellite	Service	Freq (MHz)	BW MHz	Data rate (Mb/s)
Metop	LRPT	137.9	.150	.072
Metop	AHRPT	1701.3	4.5	3.5
NPOESS	LRD	1706	8.0	3.88
NOAA/POES*	APT	137.5 – 137.62	.034	.017
NOAA/POES*	HRPT	1698 /1702.5	2.66	.665
FY-1 *	CHRPT	1698-1710	5.6	1.3308
FY-3A	AHRPT	1698-1710	5.6	4.2
Meteor 3M N2	LRPT	137.89 / 137.1	0.15	0.064
Meteor 3M N2	HRPT	1700	2.	0.665
DMSP		??	??	
GOES *	LRIT	1691.2		.128
GOES *	GVAR	1685.5		2.2
MSG *	LRIT	1691.		.128
MTSAT	LRIT	1691.		.15

Current satellite services supported by MCUT

Backup Slides

Benefits of ADM (cont.)

- Dissemination via an ADM would allow alleviation of the constraints on spacecraft station keeping without requiring antenna re-pointing by the ADM user, thus extending the lifetime of satellites and reducing cost;

- Dissemination via ADM would greatly facilitate contingency planning, whereby the impact of a satellite change could be transparent at the telecommunication level, and thus minimized for the user;

- ADM would facilitate the acquisition of multiple satellite data in an integrated way, in order to produce multi-satellite composite products.
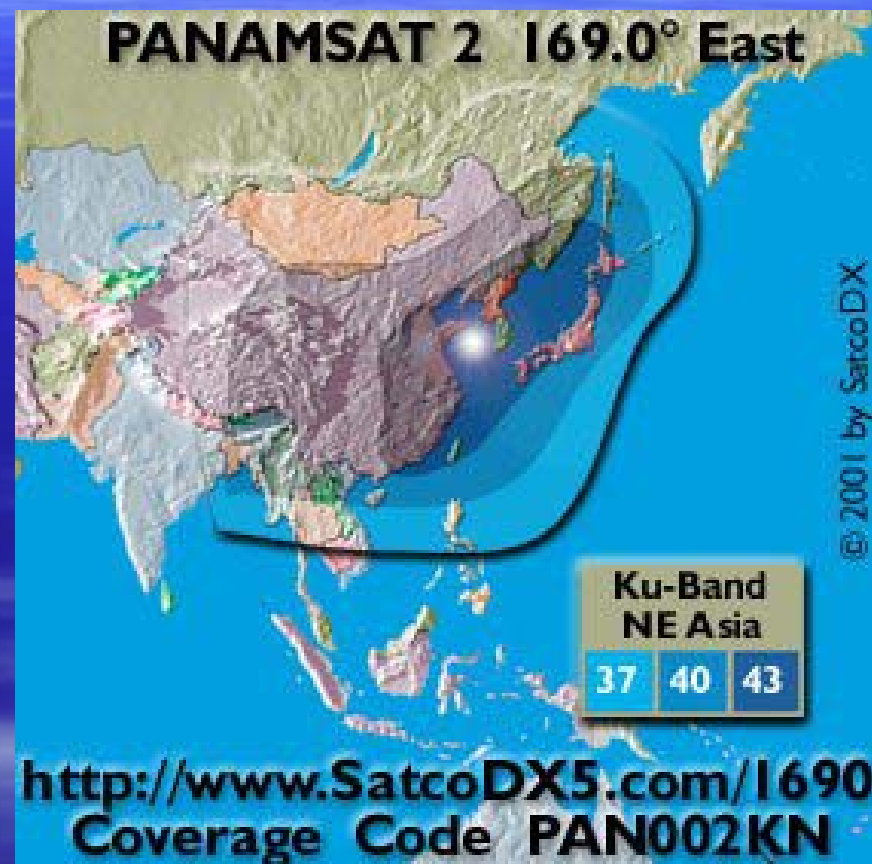
48

Panamsat 2 Distribution to Pacific

PANAMSAT 2 169.0° East

C-Band Pacific

27	30	33

http://www.SatcoDX5.com/1690
Coverage Code PAN002CP

PANAMSAT 2 169.0° East

Ku-Band NE Asia

37	40	43

http://www.SatcoDX5.com/1690
Coverage Code PAN002KN

4 GHz Downlink

EIRP powers in dBW

12 GHz Downlink

Ku-band

Antenna diameters are the minimum to provide isolation from signals from adjacent satellites

- **1.2 meter diameter antenna**
- **~ $500**
  - **Cost includes:**
    - **Includes antenna and mount**
    - **Excludes LNB (see next**

- **2.4 meter diameter antenna**
- **~ $1000**

50

Low Noise Block Downconverter

- **Affixed to offset-fed antenna**
- **Many functions combined in one unit**
- **Cost: ~ $350**

Feed horn Input (12 GHz)

Low Noise Amp
Downconverter
Local Oscillator
Isolators
Filters
Buffer Amp

BNC IF Output (1 GHz)
DC Power Line

DVB-S PCI Cards

- ITU (International Telecommunications Union) Standard
- Cost ~ $60 USD
- 16.3 to 47.2 Mbps
  - Dependent on EIRP and Bandwidth available
- Vendors:
  - Technotrend DVBsat PCI card
    - http://www.technotrend.de/english/print_files/p_pcproducts.html
  - Hauppauge WinTV DVB-s card
    - http://www.hauppauge.de/prod_nexus_s.htm
- These standard boards are deployed in many satellite TV networks:
  - Dish Network set-top box, …
  - High volume production makes for low cost

Intersil ASIC Chip Set

- Digital Quadrature Tuner
- Real or Complex inputs up to 52 MSPS
- Carrier Tracking Loop
- Matched Filter
- IF and Baseband AGC
- Digital Costas Loop
- Programmable Demodulator for BPSK, QPSK, OQPSK, 8-PSK, FSK, AM, or FM waveforms
- Soft Decision Slicing